# Expectations and the Rate of Inflation

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**NBER Summer Institute - Impulse and Propagation Meeting - July 2022**

# Expectations → Inflation?

**Q:** **Passthrough in standard models?**

# Expectations $\rightarrow$ Inflation?

- Widespread belief… **YES!**
  - managing expectations is key…
  - … expectations cause inflation…
  - … near one-for-one

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    2021: expectations anchored, inflation will be small & transitory

    2022: tighten monetary policy to lower expectations

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    2021: expectations anchored, inflation will be small & transitory

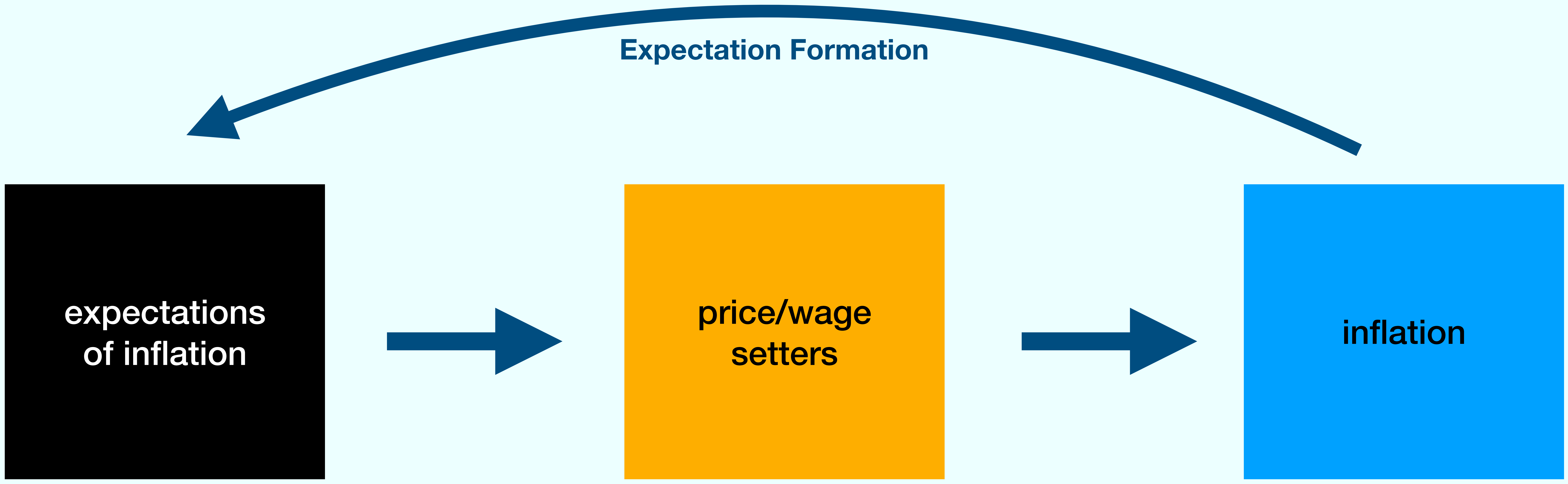
    2022: tighten monetary policy to lower expectations
- What do we know?…
  - Evidence: difficult, but some promising recent work
  - Theories: Calvo gives 1-to-1? others?…

**Q: Passthrough in standard models?**

# This Paper

- Standard pricing models…
  - time-dependent: Calvo, Taylor, general
  - state-dependent “menu costs”
- Solve: Optimal Pricing + Aggregation
- Important…
  - allow for arbitrary expectations $\pi^e$
  - “temporary equilibrium” (learning literature)
- Passthrough: $\pi = \phi \pi^e + \text{other stuff}$
- Full Phillips Curve $\pi_t = \sum \phi_s \pi^e_{t+s} + \sum \phi_s \pi_{t+s} + \cdots$


expectations of inflation
price/wage setters
inflation


Expectation Formation
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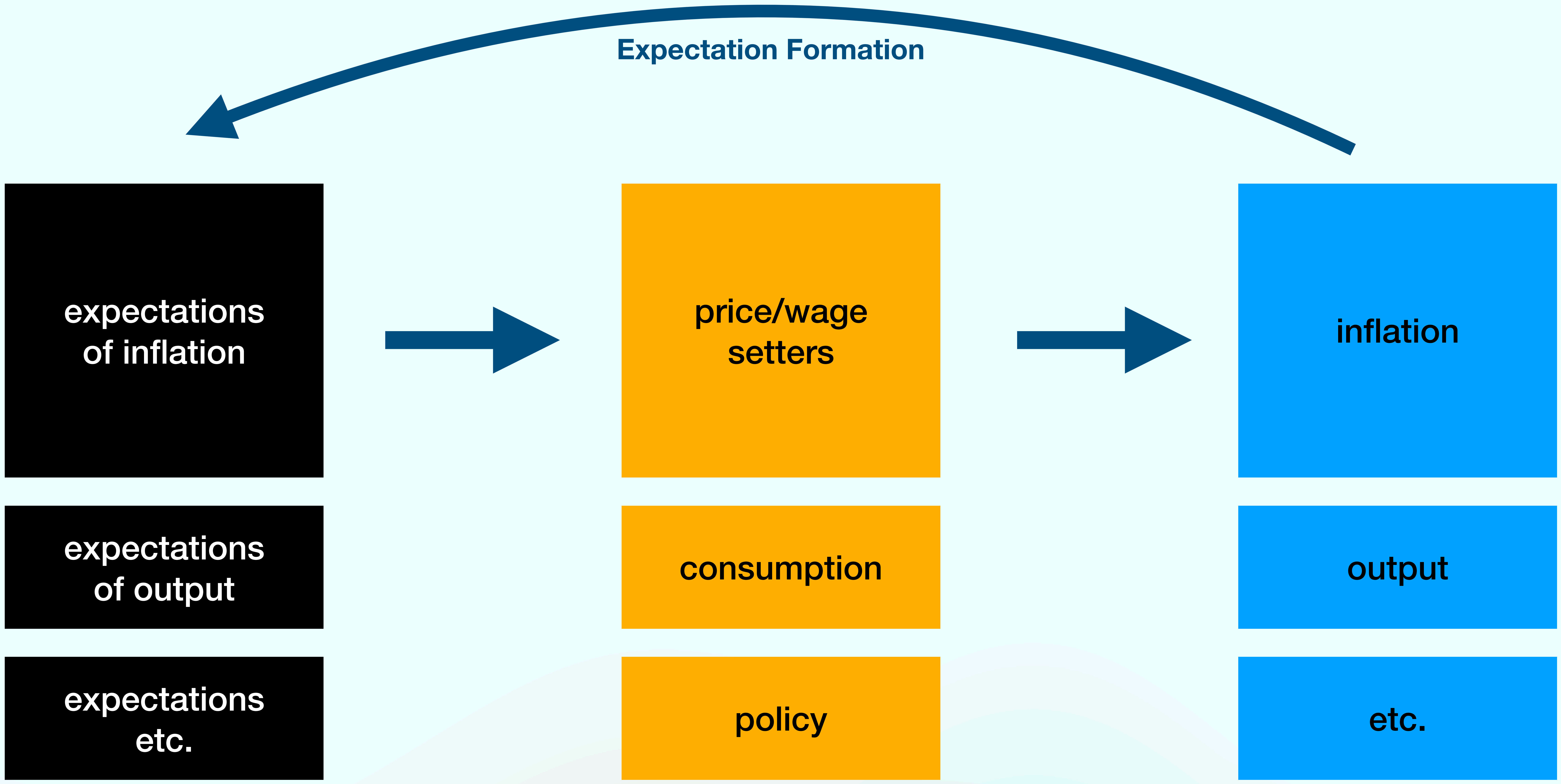
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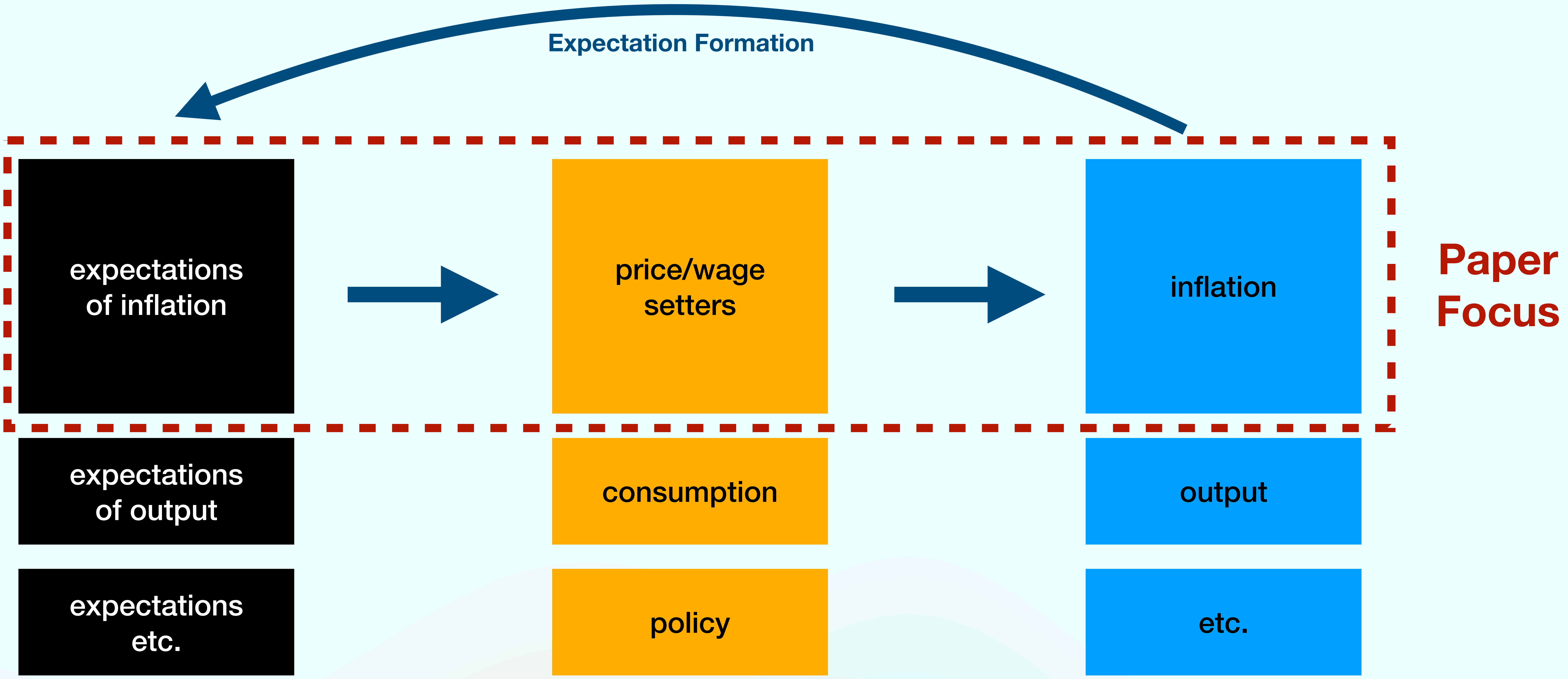
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# Contributions

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**Simple Passthrough Metric**

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**Explore Wide Range of Pricing Model**

**Simple Passthrough Metric**

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**Short vs Long Run Expectations?**

**Explore Wide Range of Pricing Model**

**Simple Passthrough Metric**

# Results #1

- Passthrough: **wide range…**
  - dependent on pricing model
  - not ~1, potentially low
- Calvo: in theory $\phi \to 0$ if prices very sticky…
  … in practice $\phi \approx 1$
- Taylor: $\phi =$ ½
- **Sufficient statistics** for general time-dependent…

$$\phi = \frac{\text{duration of ongoing}}{\text{duration of completed}}$$

# Results #2

- Q: How low can we go? A: $\phi^* =$ ½ Taylor!
- Q: How high? A: *any* $\phi > 1$!
- Full Phillips Curve…

$$\pi_t = \sum_{s=0}^{\infty} \phi_s \pi^e_{t+s} + \sum_{s=-1}^{-\infty} \phi_s \pi_{t+s} + \cdots$$

  - coefficients $\phi_s$ fall and zero outside rigidity
  - long-run Phillips curve vertical: $\sum_{s=-\infty}^{\infty} \phi_s = 1$

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**Short-run NOT Long-Run Expectations!**

# Results #3

- Basic state dependent "menu cost"…
  - passthrough extreme, very sensitive to specification…
  - Sheshinksi-Weiss: $\phi < 0$
  - Golosov-Lucas: $\phi > 1$
- Extensions…
  - Short run: fixed frequency $\phi < 1/2$
  - Menu costs for changing bands: $\phi = 0$

# Related Literature

- Empirical Expectations: Coibion-Gorodnichenko-Ropele, Coibion-Gorodnichenko-Kumar, Rosolia
- Non-Rational Expectations: Preston, Garcia-Woodford, Farhi-Werning
- Phillips Curve: Whelan, Sheedy, Wang-Werning, Auclert-Rigato—Rognlie-Straub
- Menu Costs: Sheshinski-Weiss, Alvarez-Beraja-Gonzalez-Neumeyer

# Overview

1. **Calvo $\phi = 1$**
2. Taylor $\phi = ½$
3. General Time-Dependent $\phi =$ ongoing/completed
4. Basic State Dependent
5. Extension to State Dependent

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- Goal…
  - passthrough from inflation expectation to inflation
  - holding *everything* else fixed, real marginal costs, demand, interest rates, etc.
- Wrong answer: use NK Phillips curve $\phi = \beta \approx 1$

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**Rational Expectation → inflation & real marginal costs tied up**

**Need to separate them!**

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$$p_t^* = \mu + (1 - \beta\lambda) \sum_{s=0}^{\infty} (\beta\lambda)^s (P_{t+s}^e + mc_{t+s}^e)$$

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**In practice** $\phi \approx 1$

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# Taylor $\beta \to 1$

- Fixed prices for N periods…
- … staggered across goods

$$p_t^* - P_t = \frac{1}{N}\sum_{s=0}^{N-1} P_{t+s}^e + a_t$$

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frequency

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**Sidenote: Roberts (1995) equation misinterpreted.**

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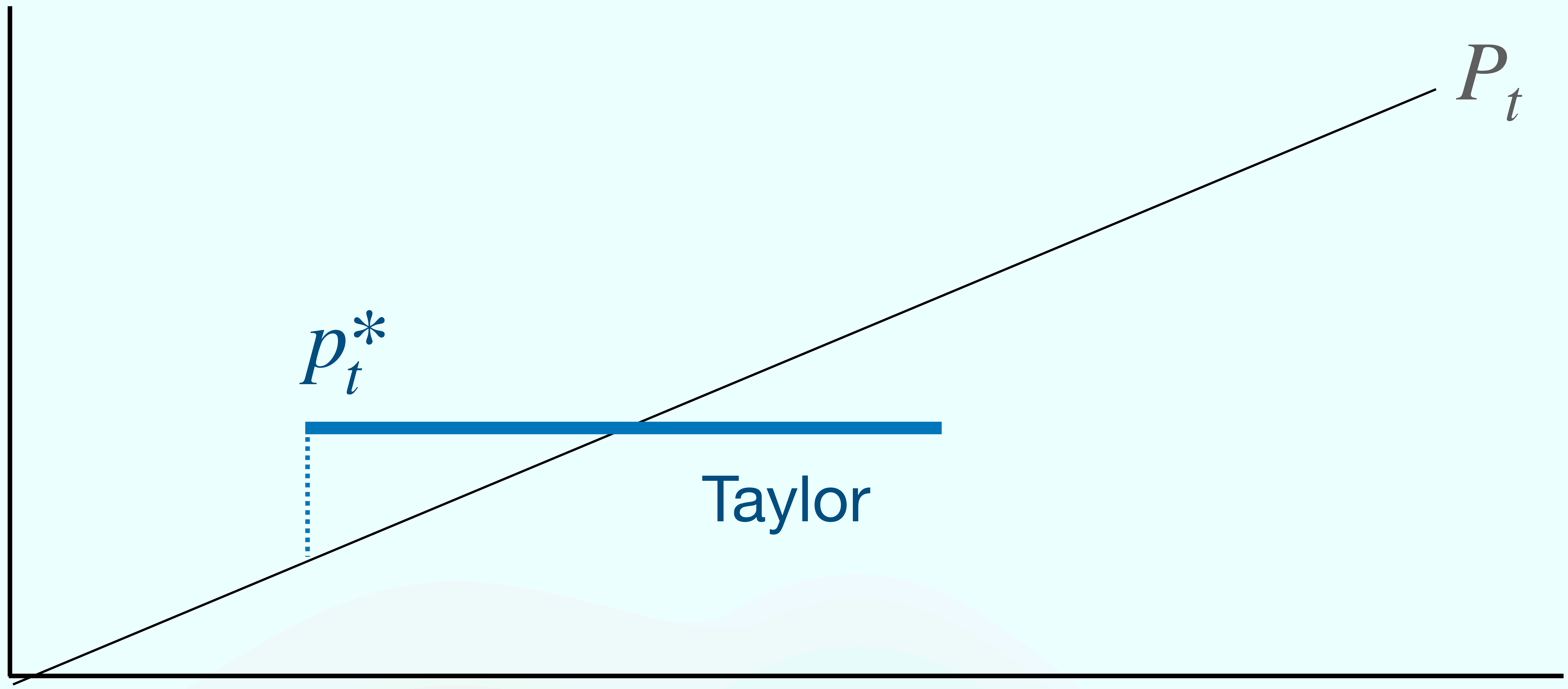

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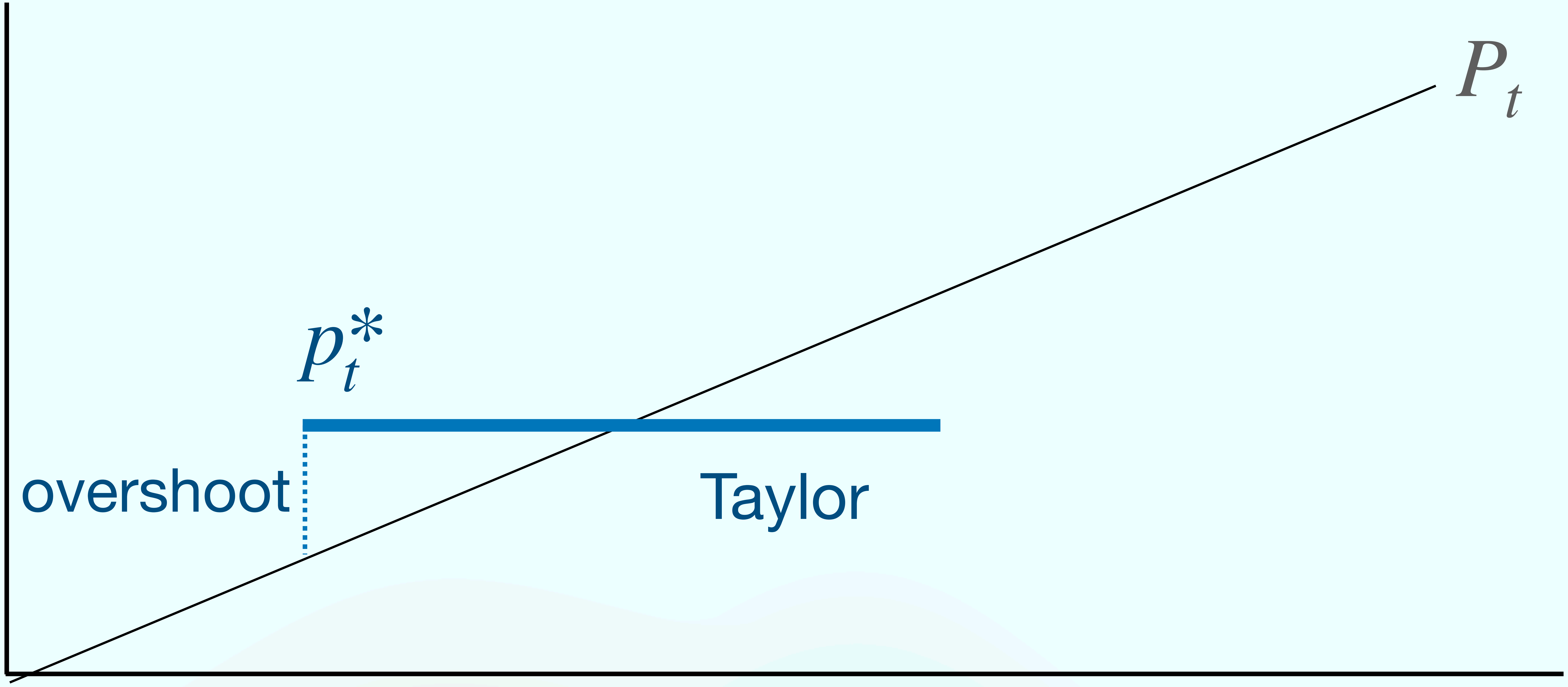

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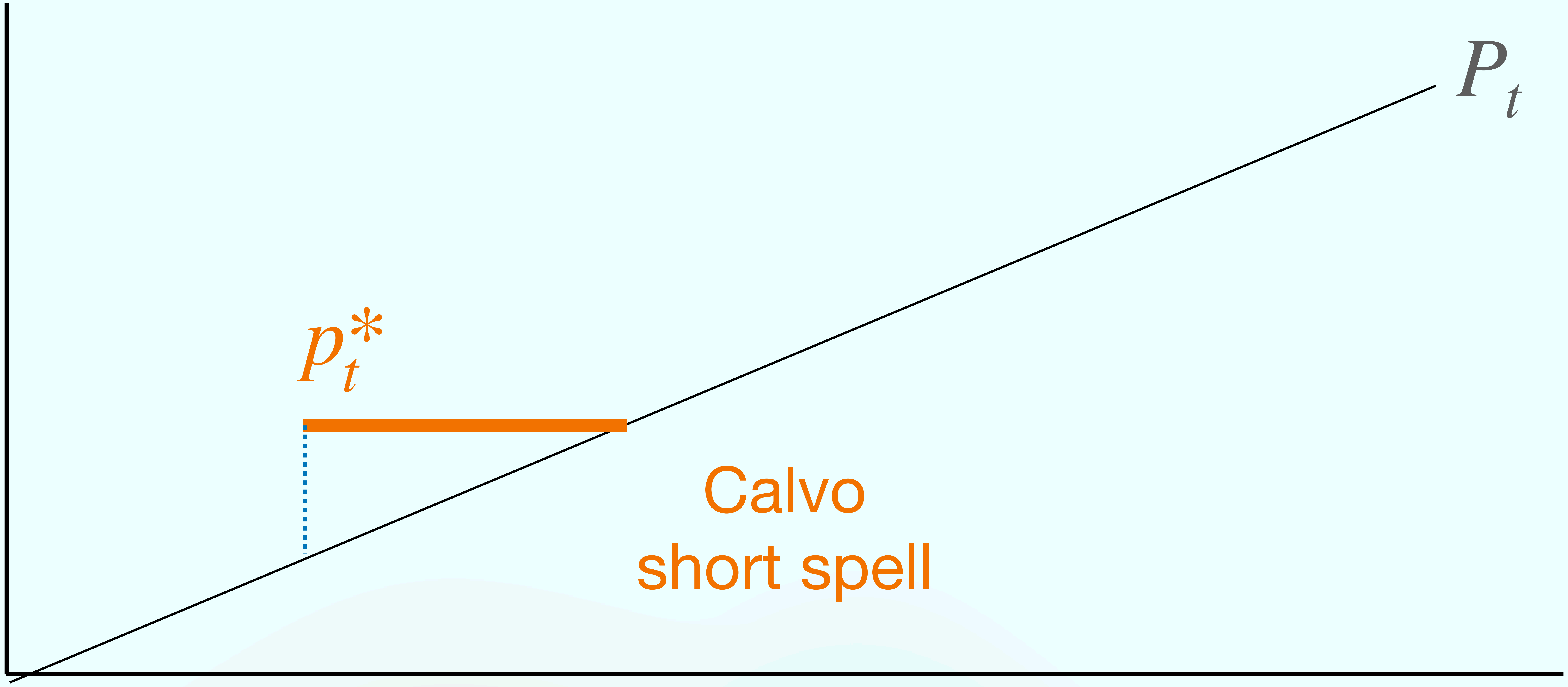

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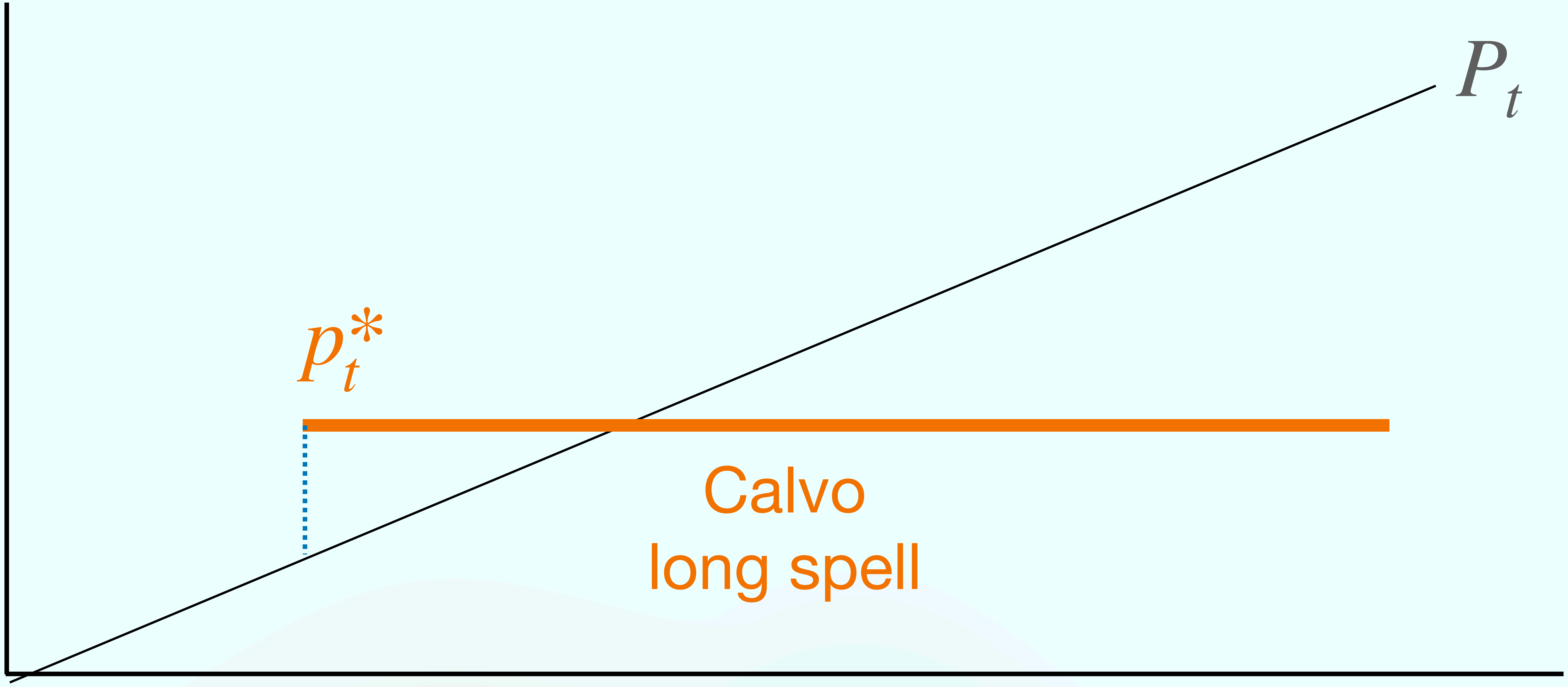

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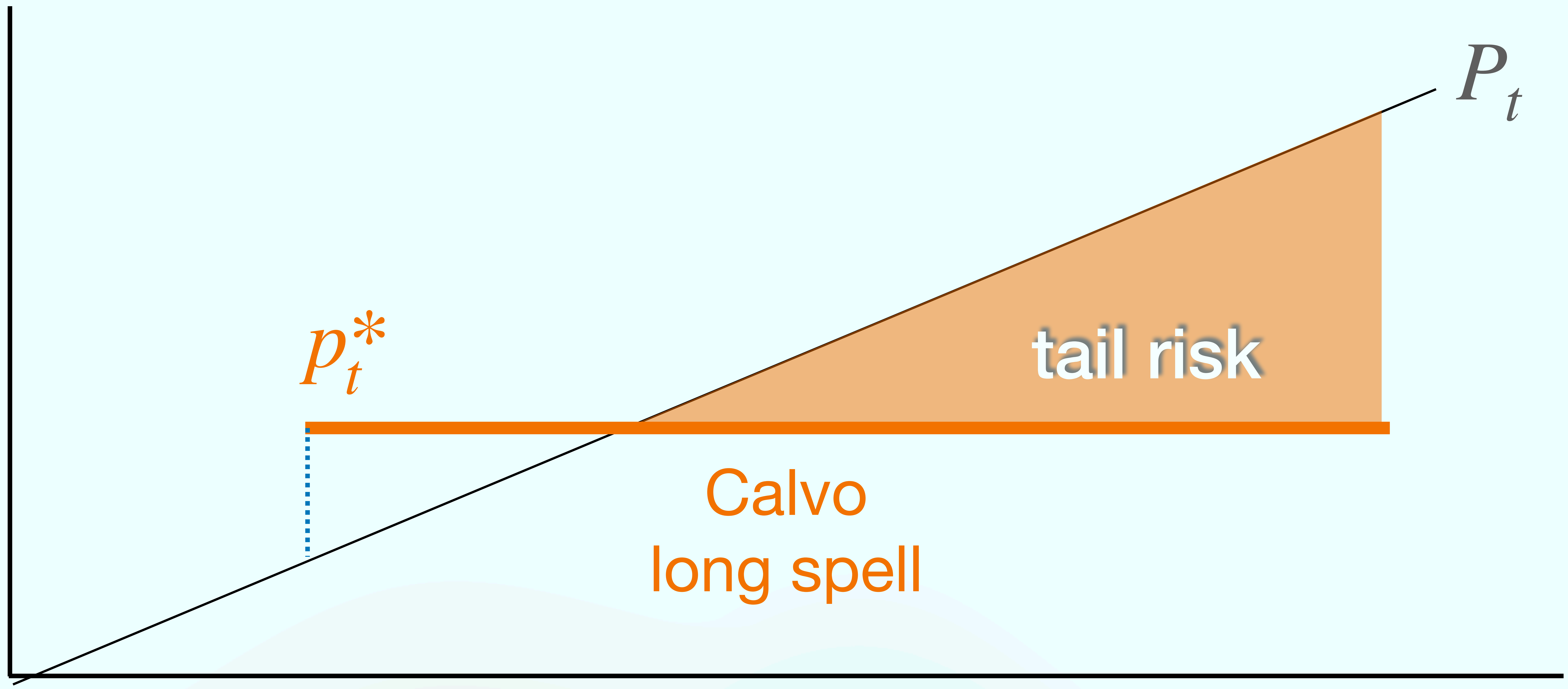

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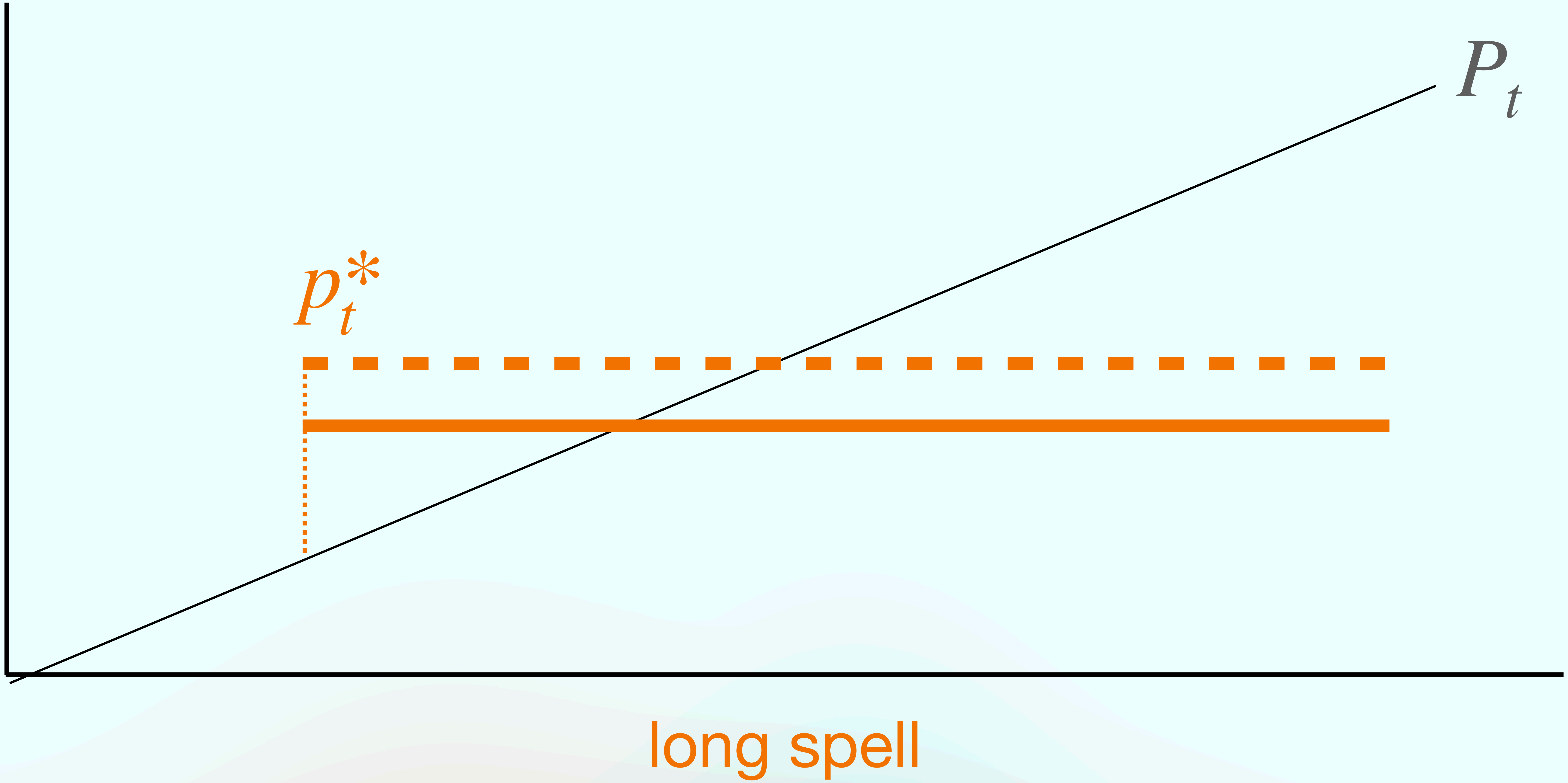

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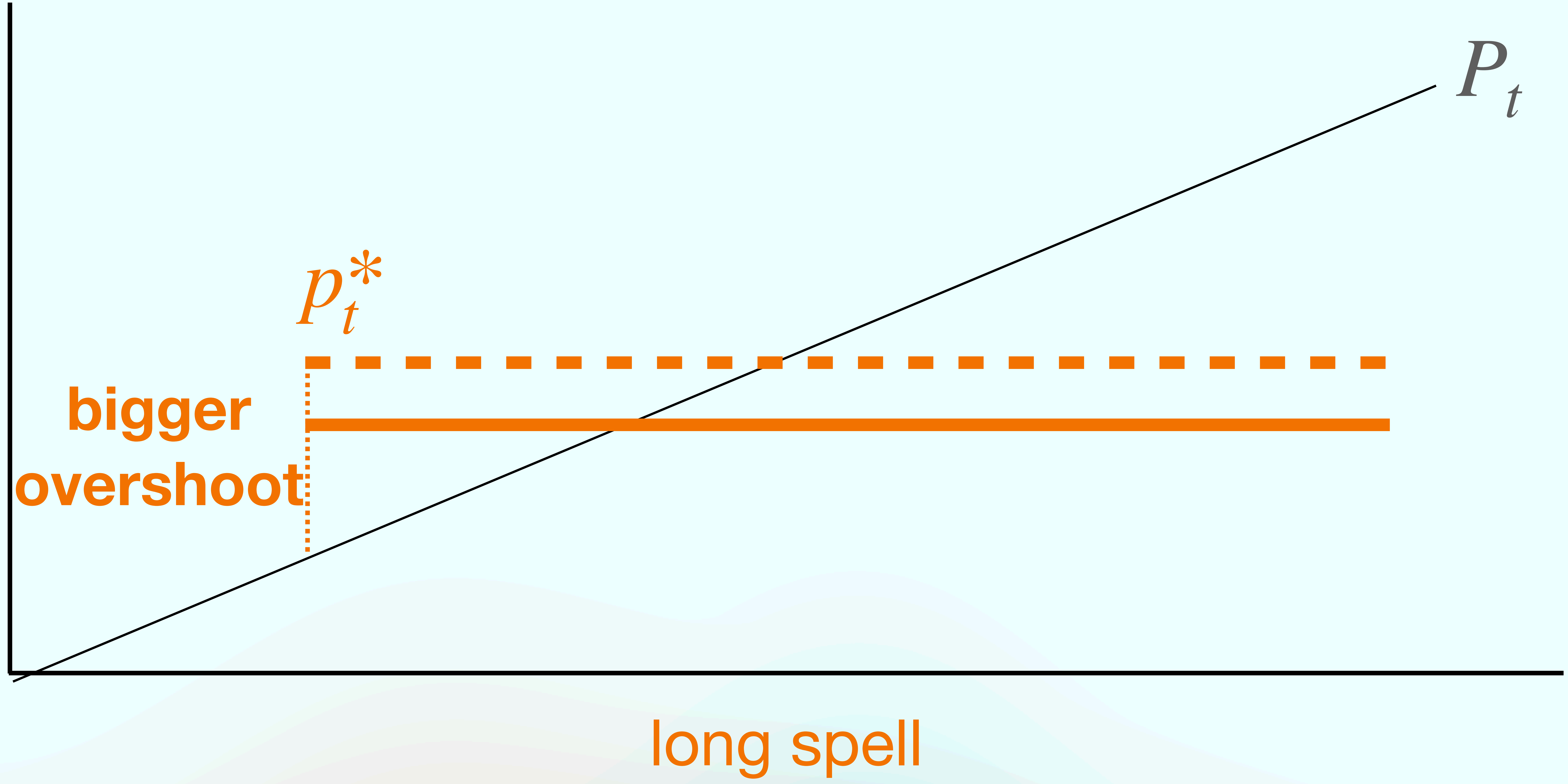

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# General Time Dependent Model

- General profit function: complementarities, markups, real marginal costs etc.
- General hazard rate $\{h_s\}$ for $s = 0,1,\ldots$
- Two probability densities…
  - completed spells $f_s$ (fraction of spells ending at s)
  - ongoing spells $\omega_s$ (fraction time spent at s)
- Accounting…

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$$\bar{h} = \sum_{s=0}^{\infty} \omega_s h_s = \frac{1}{\bar{d}}$$

frequency

$$\bar{d} = \sum_{s=0}^{\infty} f_s s$$

completed duration

$$\hat{d} = \sum_{s=0}^{\infty} \omega_s s$$

ongoing duration

# General Time Dependent Model $\beta \to 1$

$$\phi = \bar{h} \sum_{s=0}^{\infty} \omega_s (1 + s) = \frac{\sum_{s=0}^{\infty} \omega_s (1 + s)}{\sum_{s=0}^{\infty} f_s (1 + s)} = \frac{\hat{d}}{\bar{d}}$$

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# Phillips Curve

**Proposition.**

$$\pi_t = \sum_{s=0}^{\infty} \phi_s \pi^e_{t+s} + \sum_{s=-1}^{-\infty} \phi_s \pi_{t+s} + a_t$$

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- Sheedy (2010) Rational Expectations: $\hat{\phi}_1 = 1$ (as NK) and $\hat{\phi}_s < 0$

# Overview

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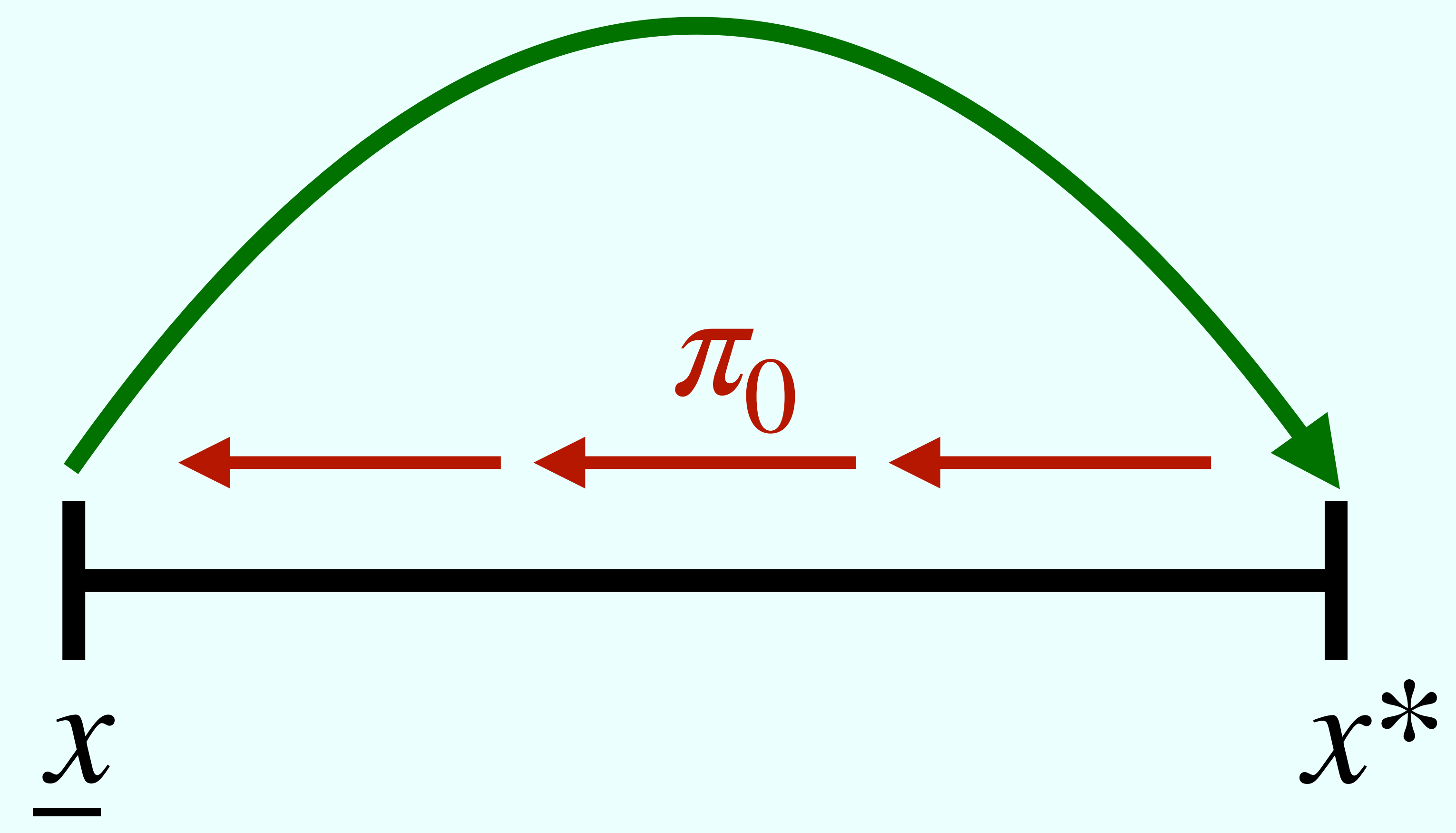
4. **State Dependent**
5. State Dependent with Frictions

# State Dependent “Menu Costs”



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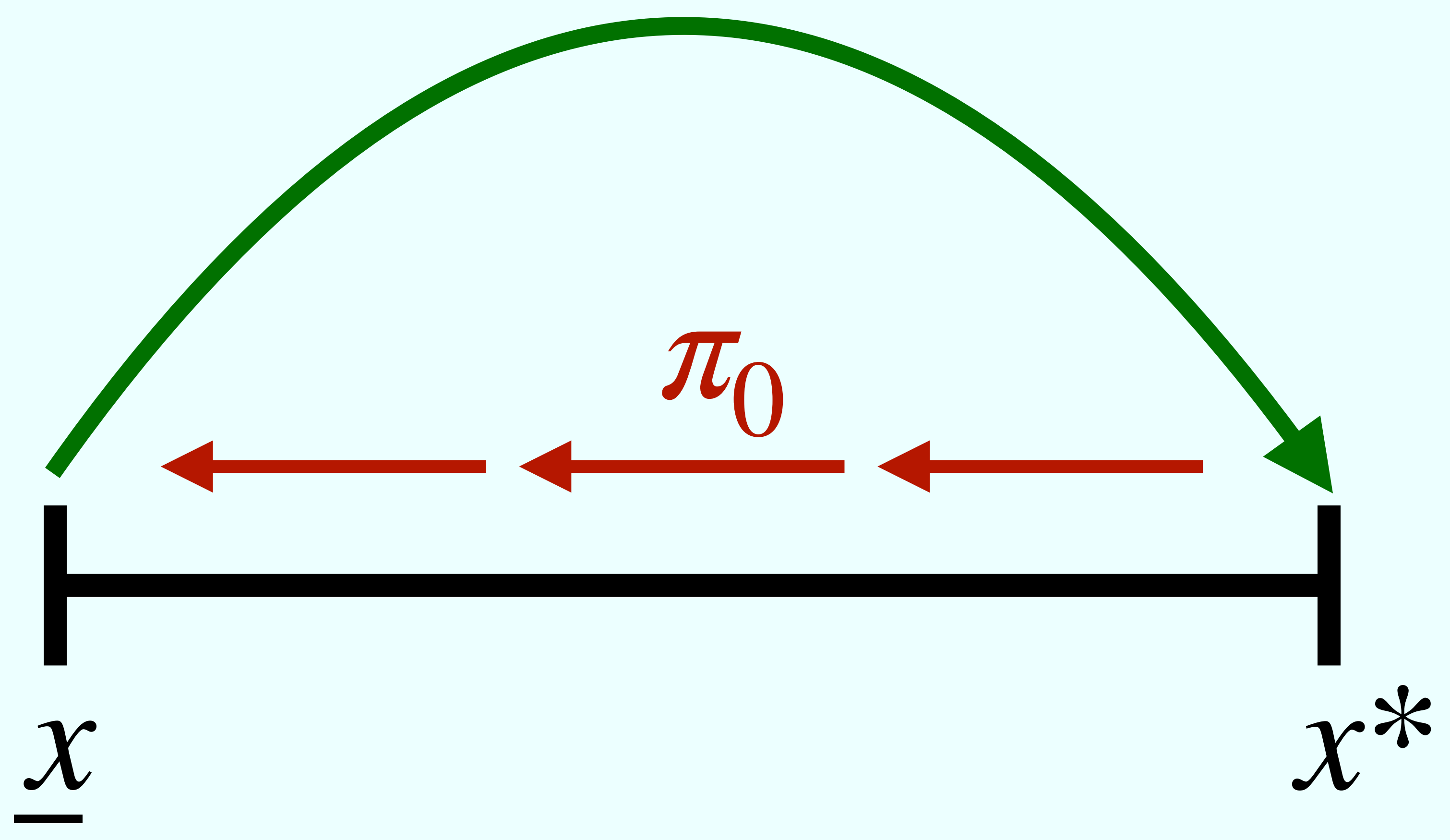
  - menu cost c of changing price
  - constant inflation $\pi$
  - bands for $x = p - P$



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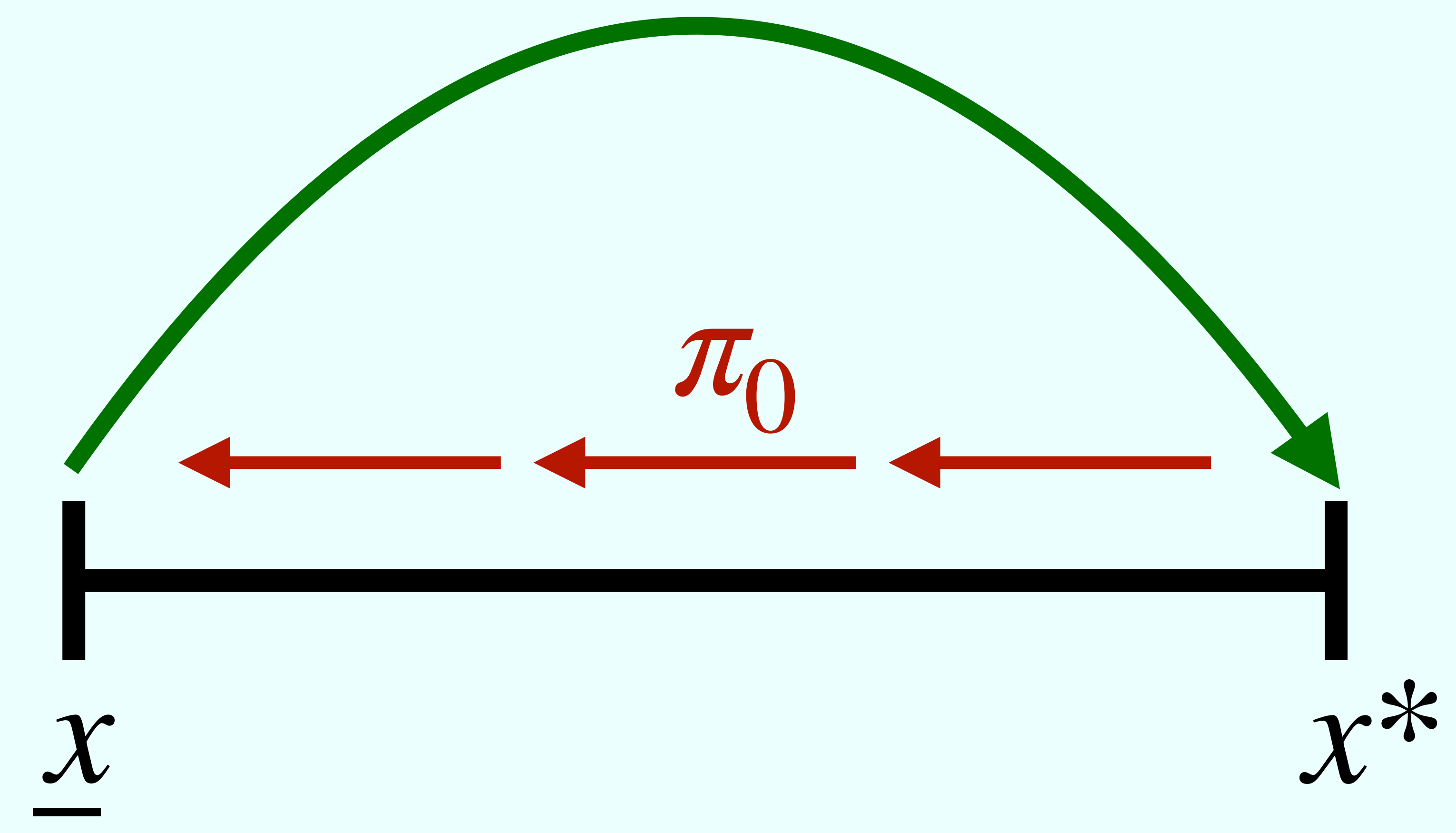


- Out of Steady Steady…
  - start at steady state $\pi_0$
  - shock expectations: $\pi^e$ rises
  - **what do firms do on in short run?**

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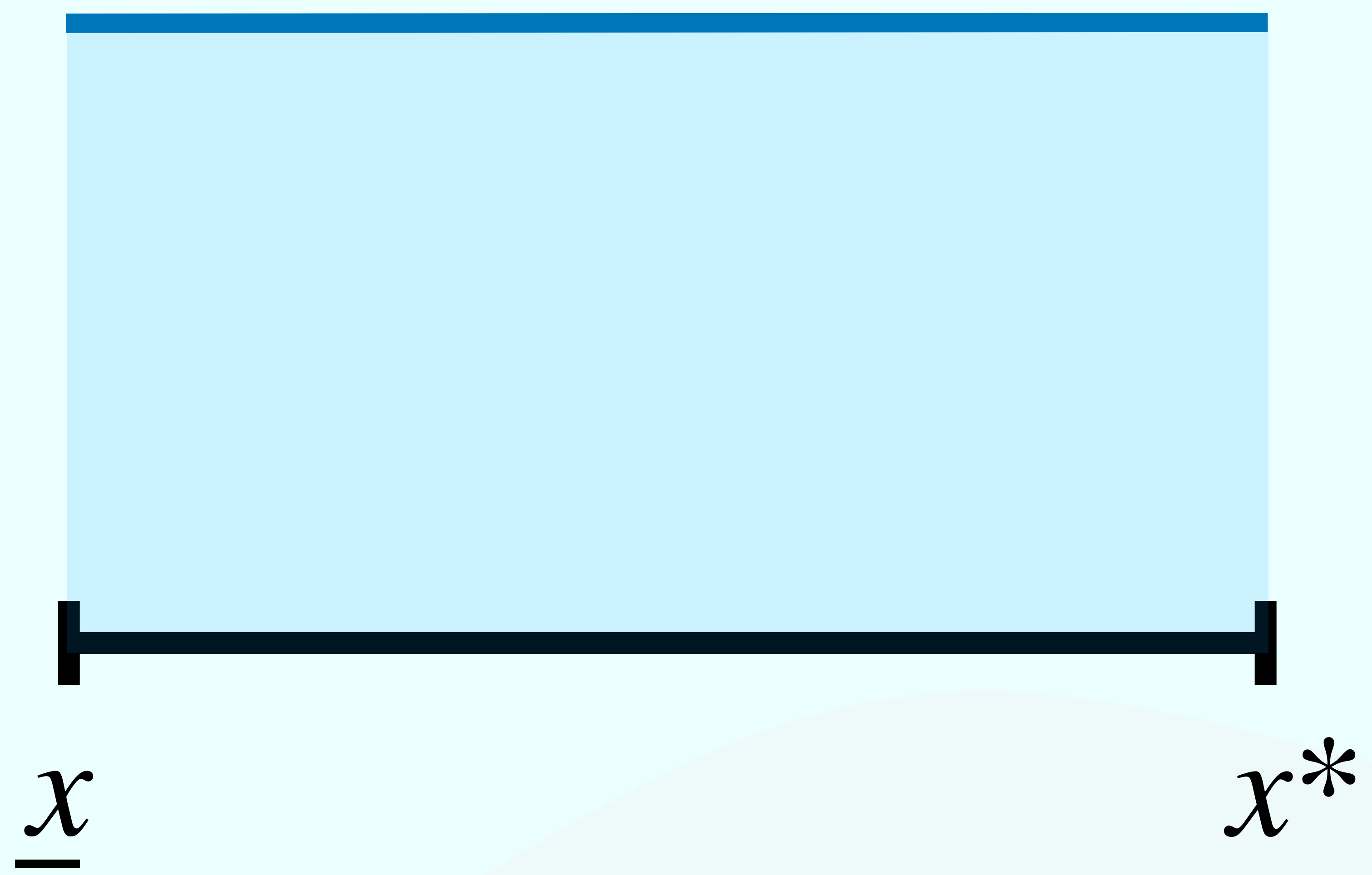

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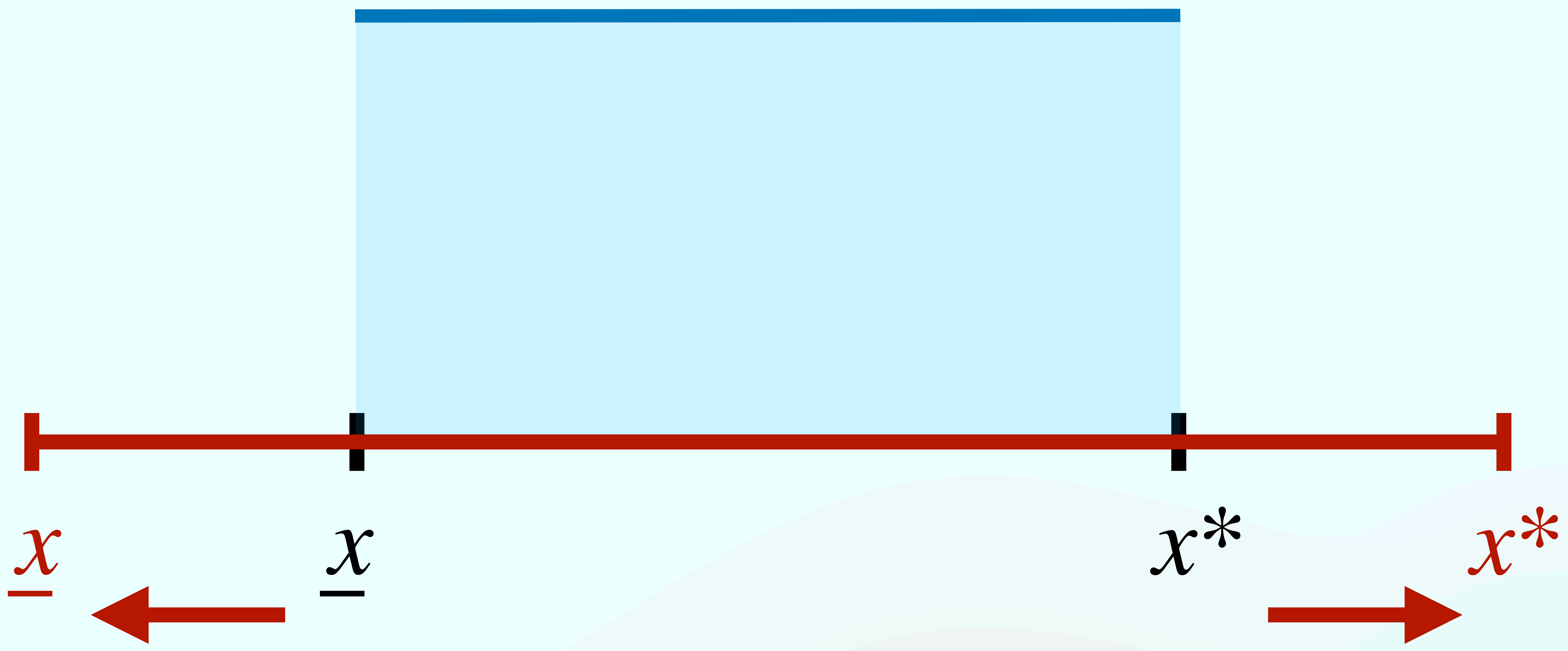

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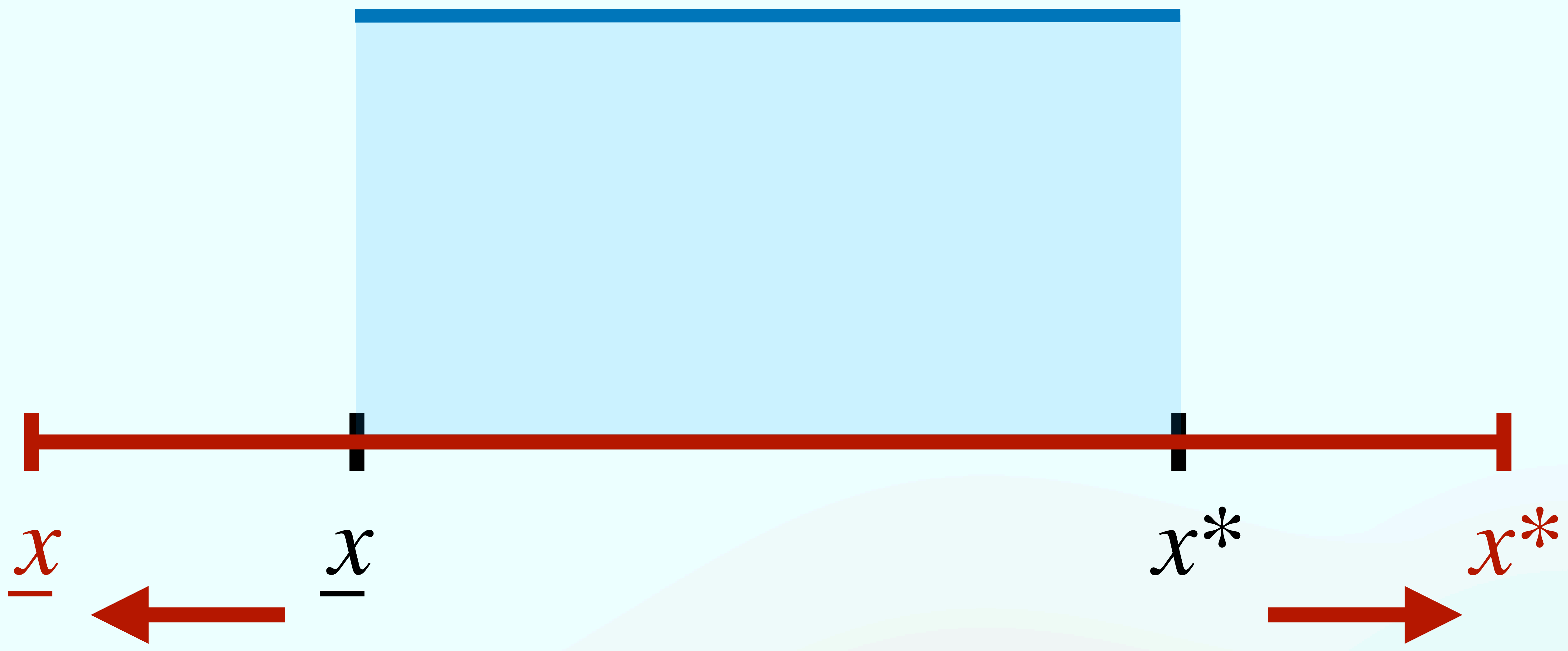


**No Price Changes!**

$\downarrow$

$\pi = 0$

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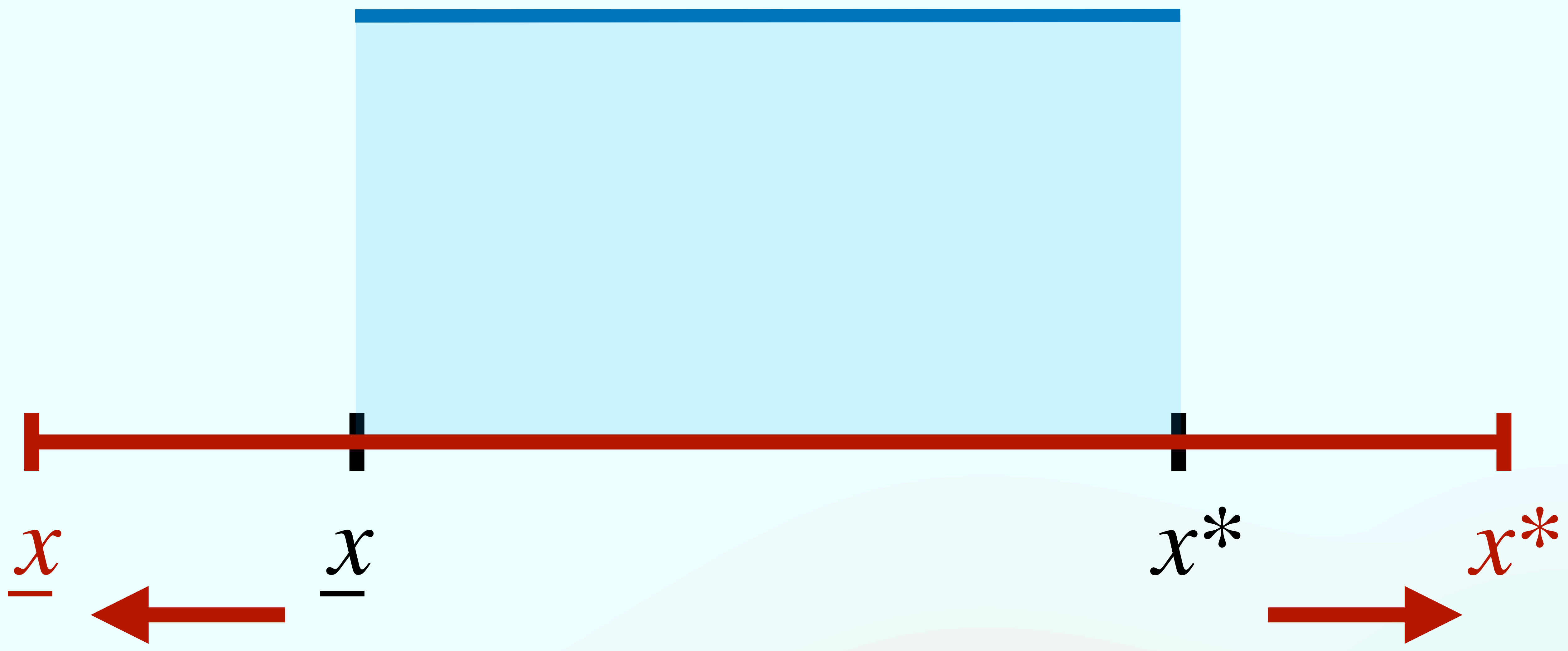


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$\pi = 0$

**Proposition.** (Sheshinksi-Weiss)

a. $\uparrow \pi^e$ $\quad \pi = 0$

b. $\downarrow \pi^e$ $\quad P_+ > P_-$

“$\phi = -\infty$”

# Overview

1. Calvo $\phi = 1$
2. Taylor $\phi = ½$
3. General Time-Dependent $\phi = \text{ongoing/completed}$
4. Basic State Dependent
5. **Extension to State Dependent**

# State Dependent

- Extreme shifts in frequency of price changes
- Realistic? Maybe not…
  - Firms *really* stop changing prices? Unlikely!
  - Two ideas…
    - short-run fixed frequency
    - fixed costs of changing bands

# Short Run Frictions (Extension #1)

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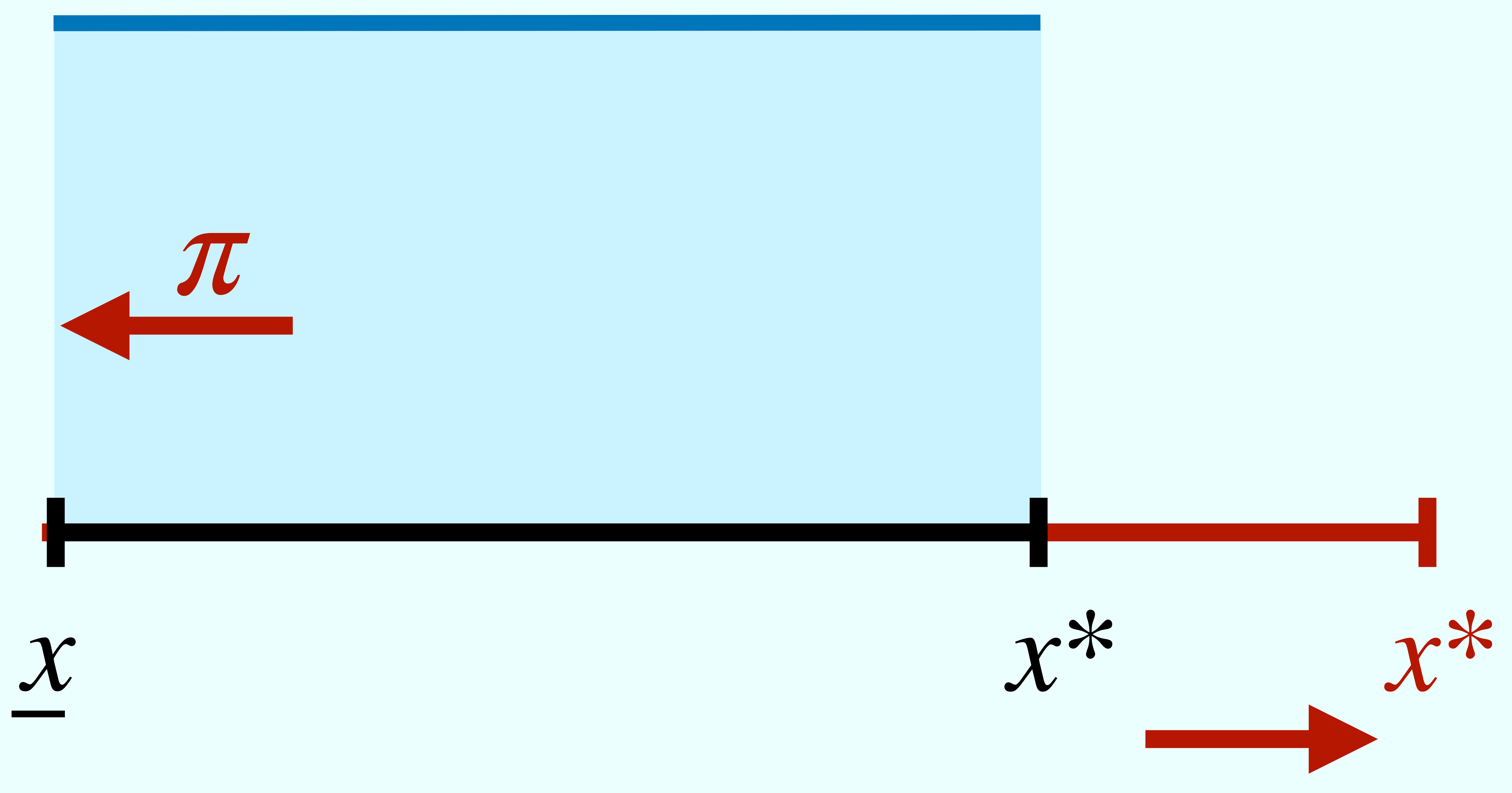
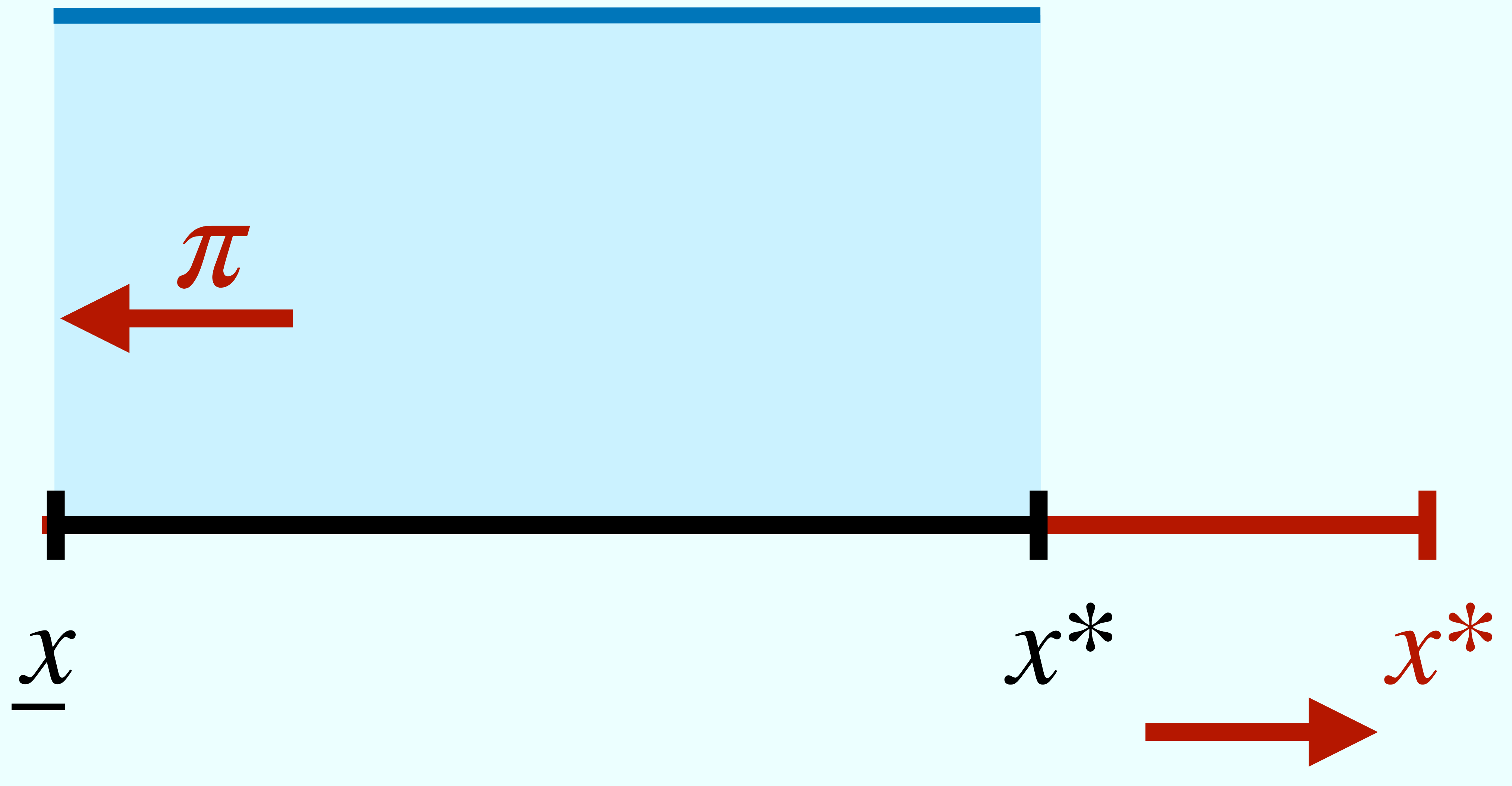
- Idea…
  - devoted resources for changing prices
  - fixed in very short run (or adjustment costs)…
  - … but not in medium run
- Optimal…
  - firm keeps changing lowest prices
  - how much upper bound?




$$\pi = \bar{h}(x^* - \underline{x})$$

fixed — adjusts — fixed

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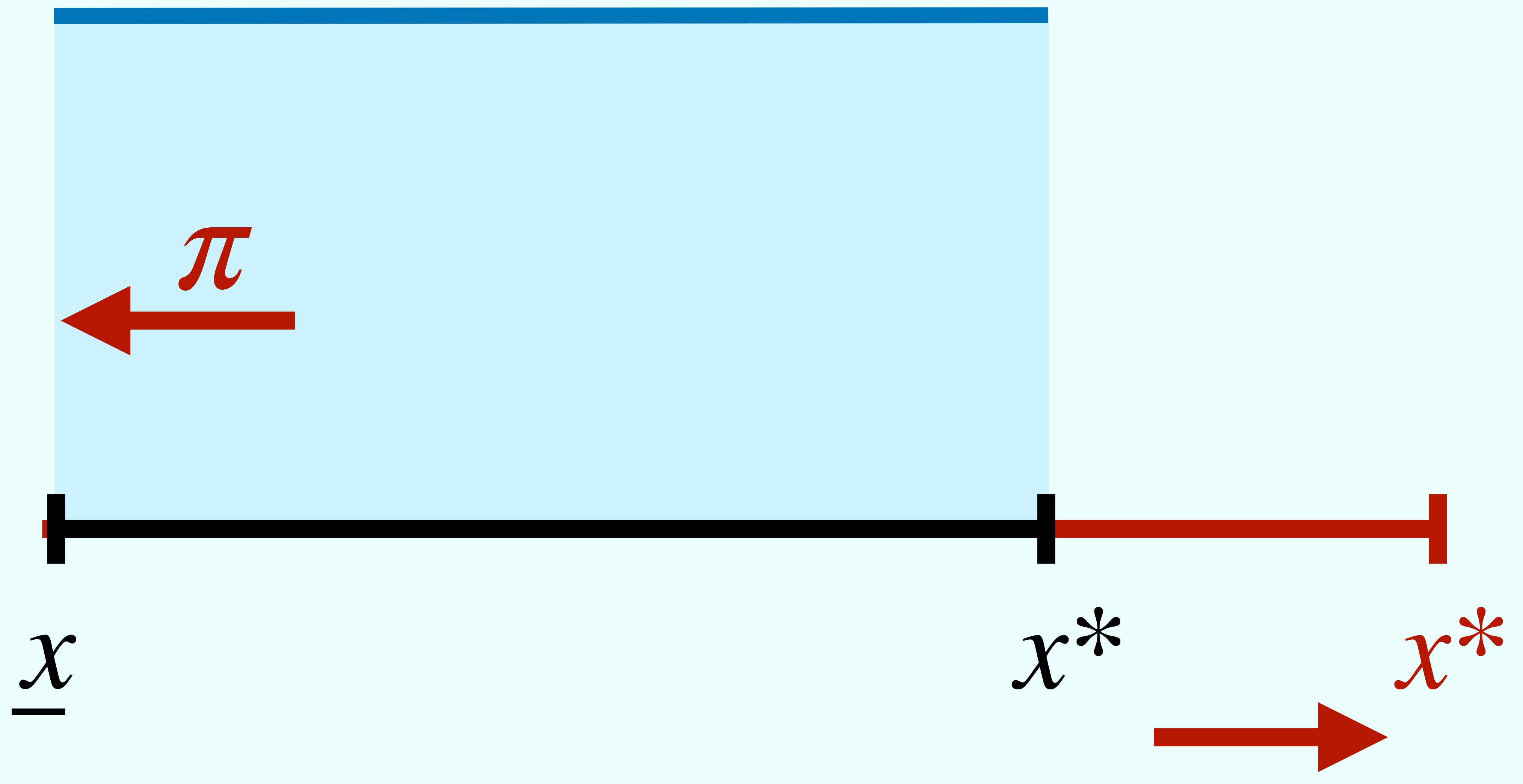
**Proposition.** Sheshinksi-Weiss with Short Run Friction

$$\phi \in (0,½)$$

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**Proposition.** **Sheshinksi-Weiss with Short Run Friction**

$$\phi \in (0, \tfrac{1}{2})$$

- Intuition…
  - adjust reset price up, **but less than Taylor!**
  - firm anticipates adjusting reset price more quickly

# Intuition: Modern Times (1936)

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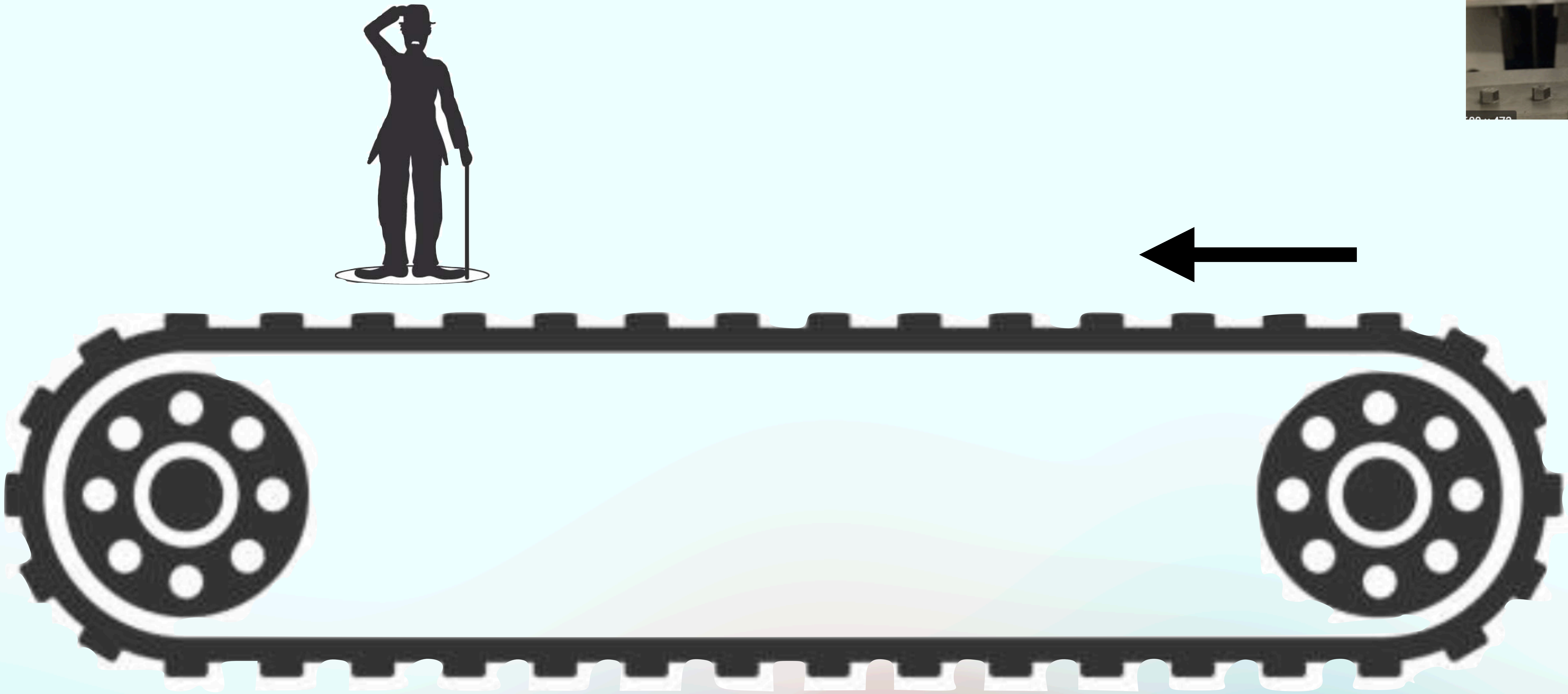

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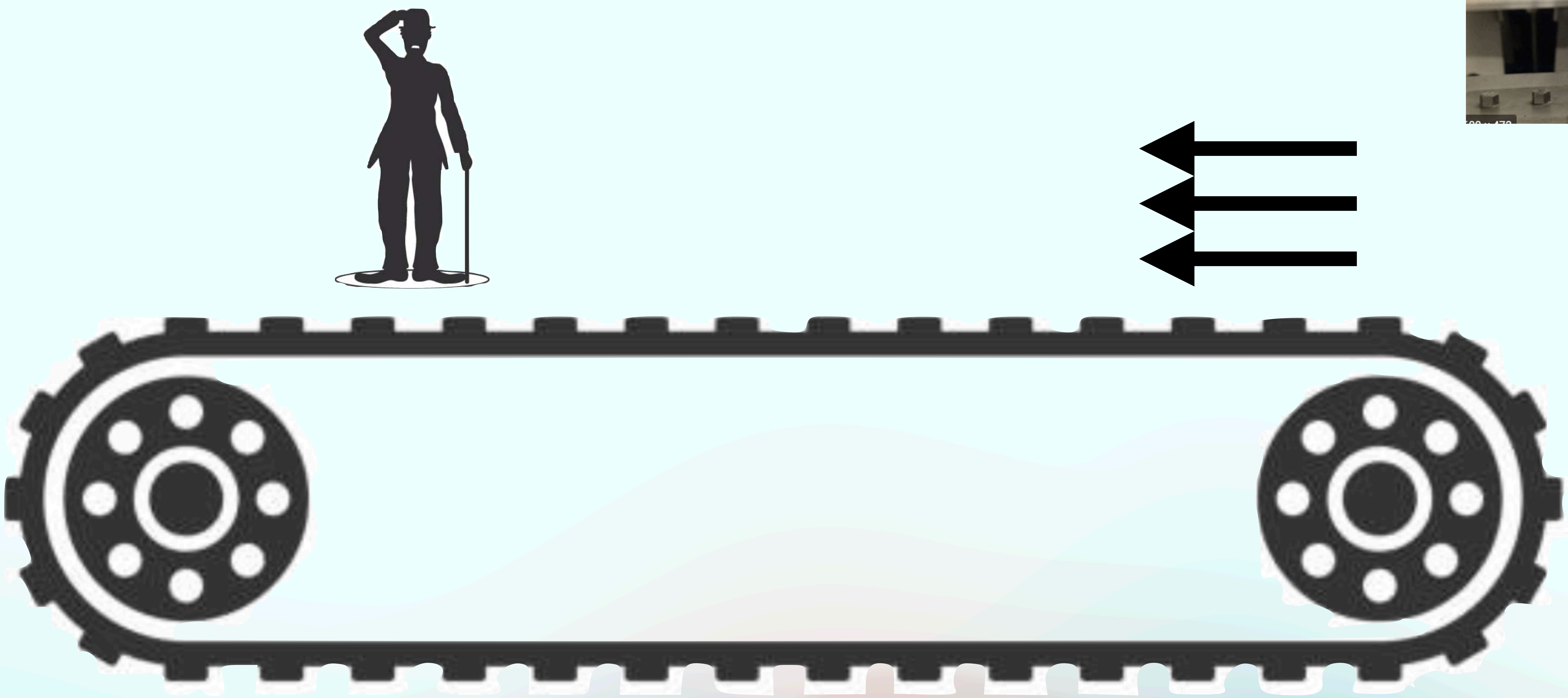

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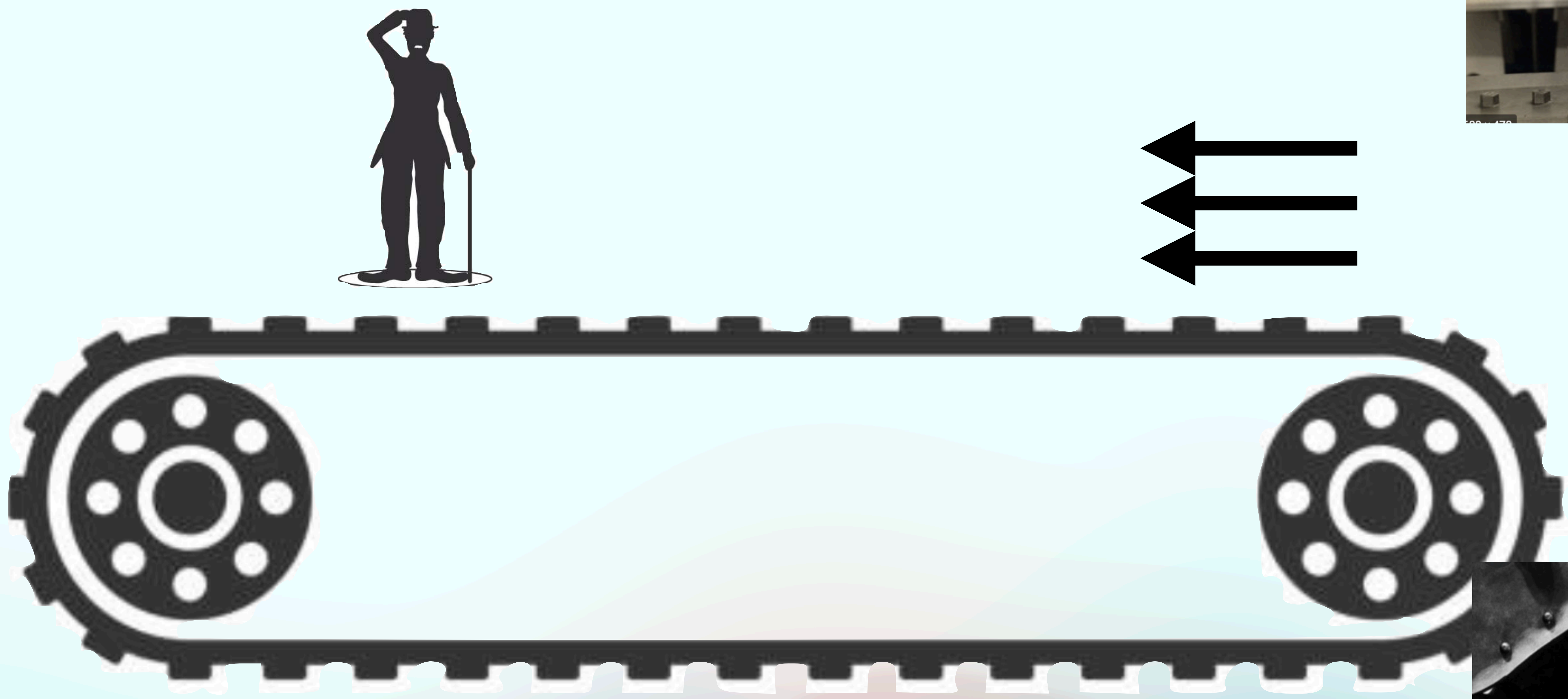

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  - cost of menus/stickers
  - manager time
- … but changing pricing *also* incurs manager time!

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$$V(\underline{x}(\pi_0), x^*(\pi_0), \pi^e) \geq V^*(\pi^e) + c_B$$

**Proposition.**

a. inaction region: $\pi^e \in [\underline{\pi}, \bar{\pi}] \implies \phi = 0$

b. $\bar{\pi}$ increasing in $c_B$ and

$$\frac{\partial}{\partial c_B} \bar{\pi} \,\Big|_{c_b=0} = \infty$$

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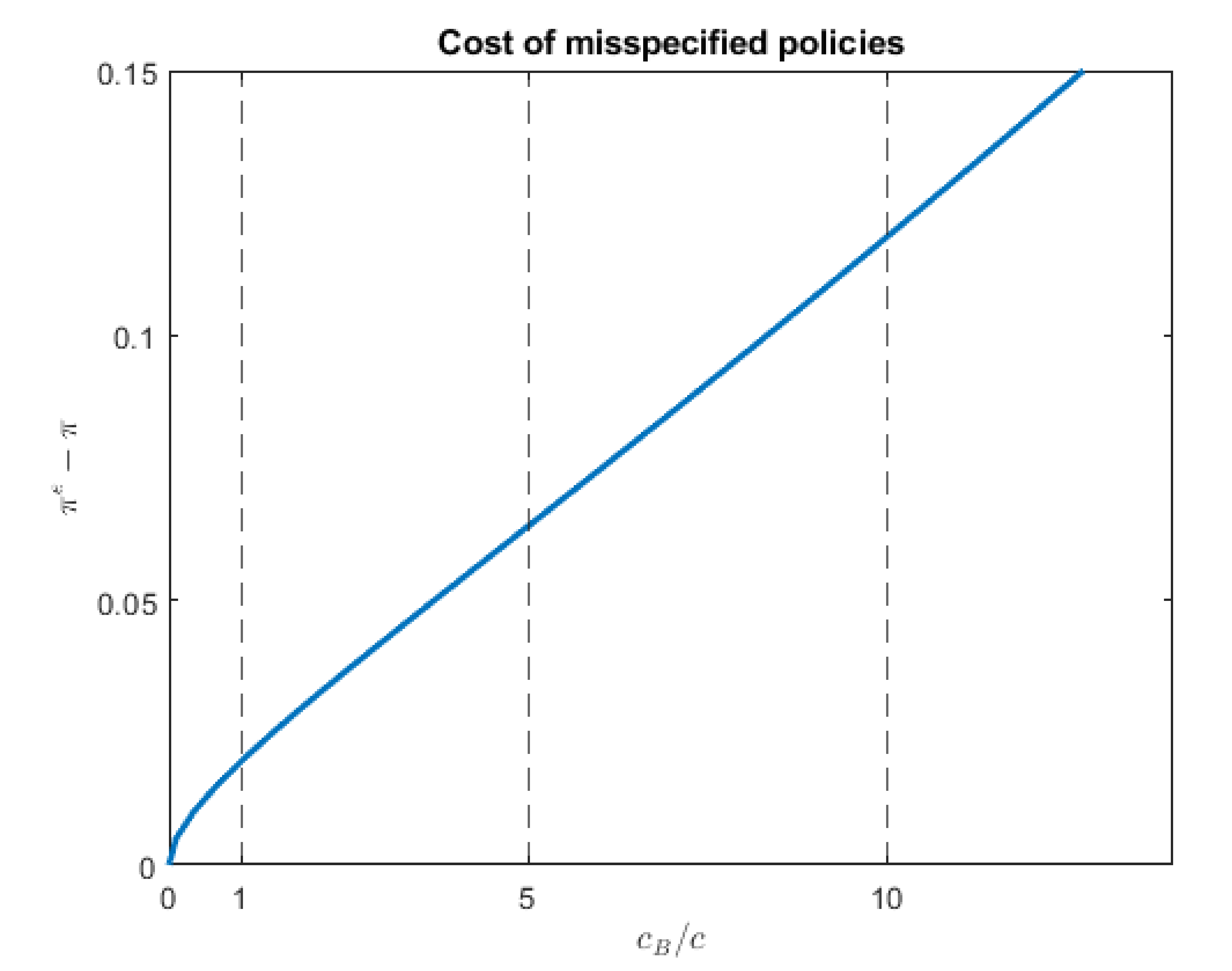

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- Adds idioysncratic shocks… (follow Alvarez et al)
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- Generation 3.0 menu cost models? (N goods, free price changes, etc.)

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- Results…
  - time dependent: lower passthrough than 1, sufficient statistics, short-run expectations …
  - state dependent: extreme, added frictions
- Other benefits?…
  - inspect mechanisms: economic intuition (overshoot)
  - look at other shocks in menu costs than just monetary policy
  - suggests extensions of menu cost models
  - spillovers to learning: inspect feedback (understood to be important)
  - spillover to empirics: measure overshoot, sufficient stats, …

# Inattention and Behavioral Agents

- Other options to affect response of inflation
    - agents do not revise expectations
    - or just do not act on them:
  - Examples: rational inattention, imperfect information, Hybrid NK Phillips curve